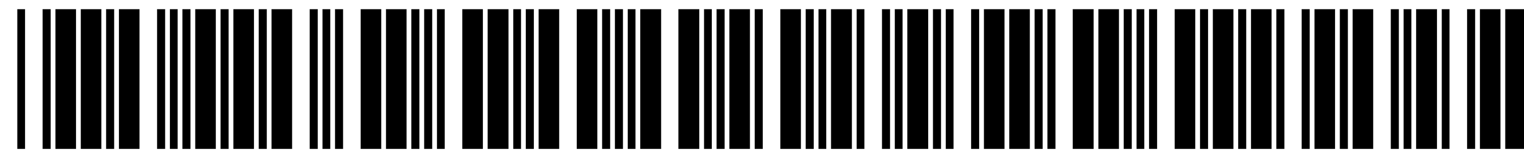

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(54) **STATIONARY AND PIVOTABLE TRAYS FOR SEMICONDUCTOR WAFER TRANSFER**

(75) Inventor: **Yin-Cheng Ma**, Taipei (TW)

(73) Assignee: **Taiwan Semiconductor Manufacturing Co., Ltd**, Hsin Chu (TW)

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(52) **U.S. Cl.** **141/86**; 141/1; 141/98; 141/163; 414/935; 414/940

(58) **Field of Search** 141/1, 11, 69, 141/83, 85, 86, 87, 88, 98, 129, 163; 118/500; 414/935, 940, 941

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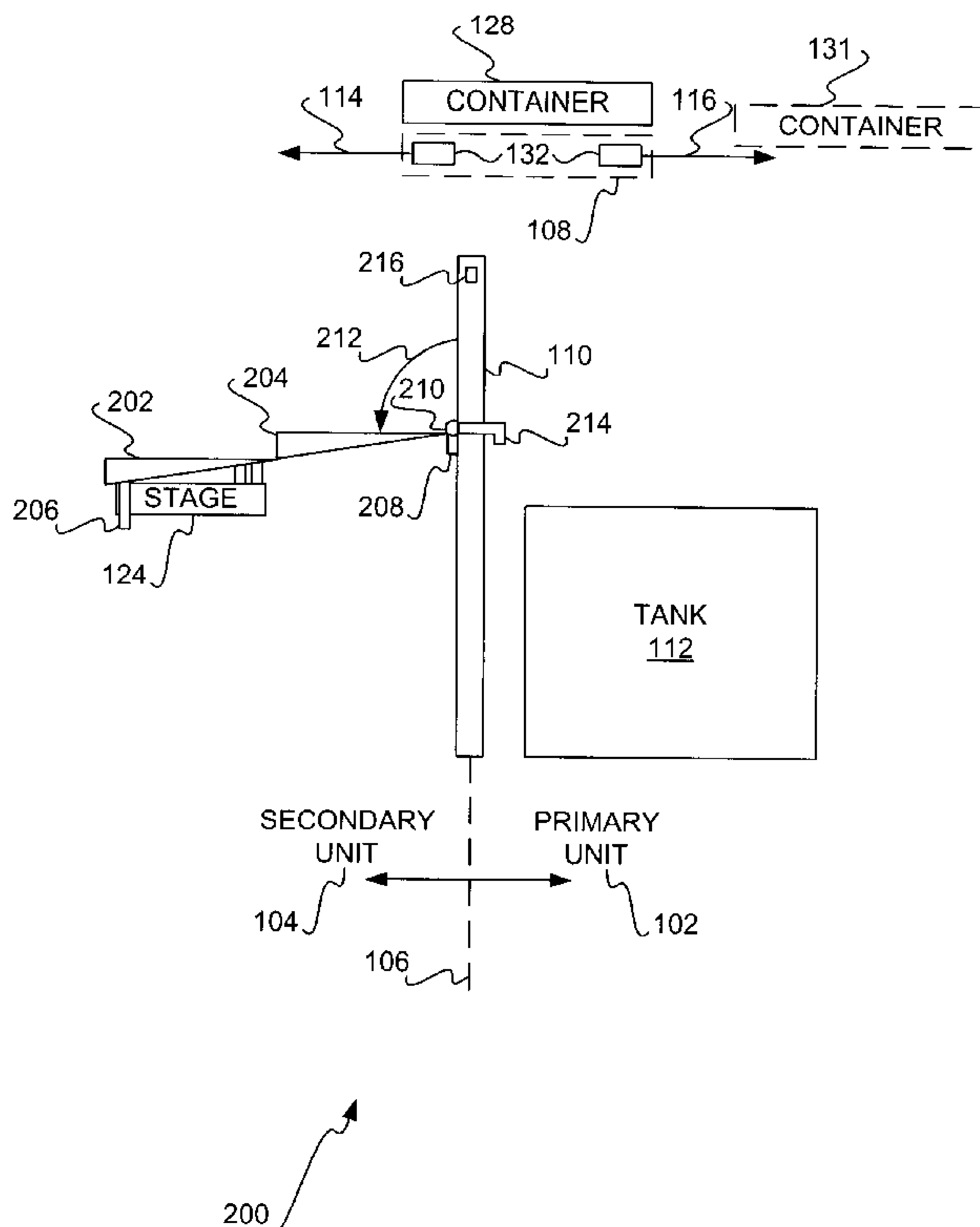
Primary Examiner—Timothy L. Maust
(74) *Attorney, Agent, or Firm*—Tung & Associates

(57) **ABSTRACT**

Stationary and pivotable trays for semiconductor wafer transfer are disclosed. A first moving equipment is movable to move a container for holding one or more semiconductor wafers from a wafer loading and unloading position to a wafer tank immersion position. A second moving equipment is movable to move the container from the wafer loading and unloading position to a container loading and unloading position. A stationary tray is located under the wafer loading and unloading position to collect liquid dripping from the first moving equipment. A pivotable tray is located to one side of the stationary tray, to collect the liquid dripping from the first moving equipment when this equipment is moving to the wafer loading and unloading position, such that the pivotable tray is lowered. The pivotable tray is raised when the second moving equipment is moving to the wafer loading and unloading position.

20 Claims, 6 Drawing Sheets



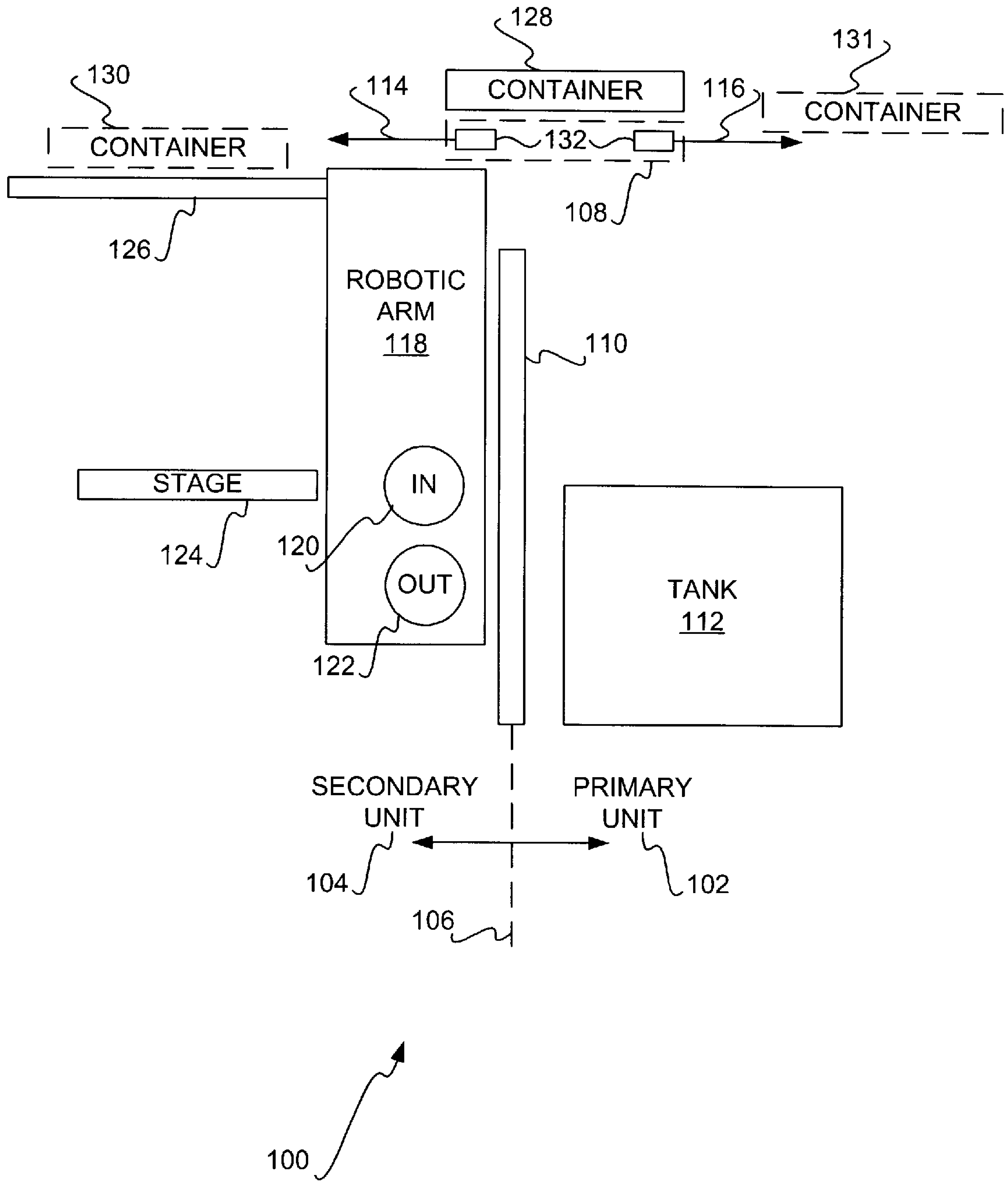

PRIOR ART
FIG 1
128
CONTAINER
131
CONTAINER
130
CONTAINER
114
116
132
108
126
ROBOTIC
ARM
118
110
STAGE
124
IN
120
OUT
122
TANK
112
SECONDARY
UNIT
PRIMARY
UNIT
104
102
106
100

FIG 2A

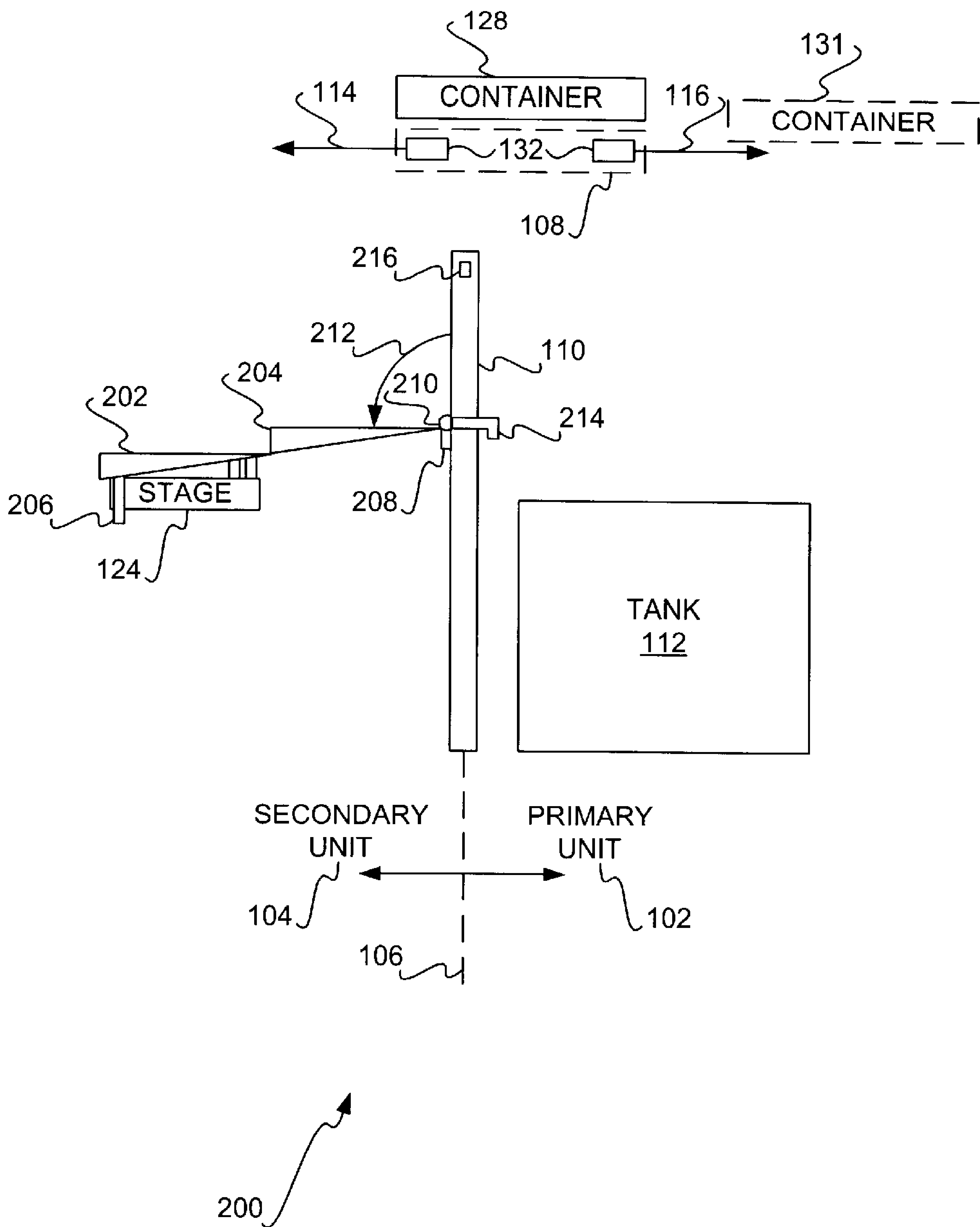
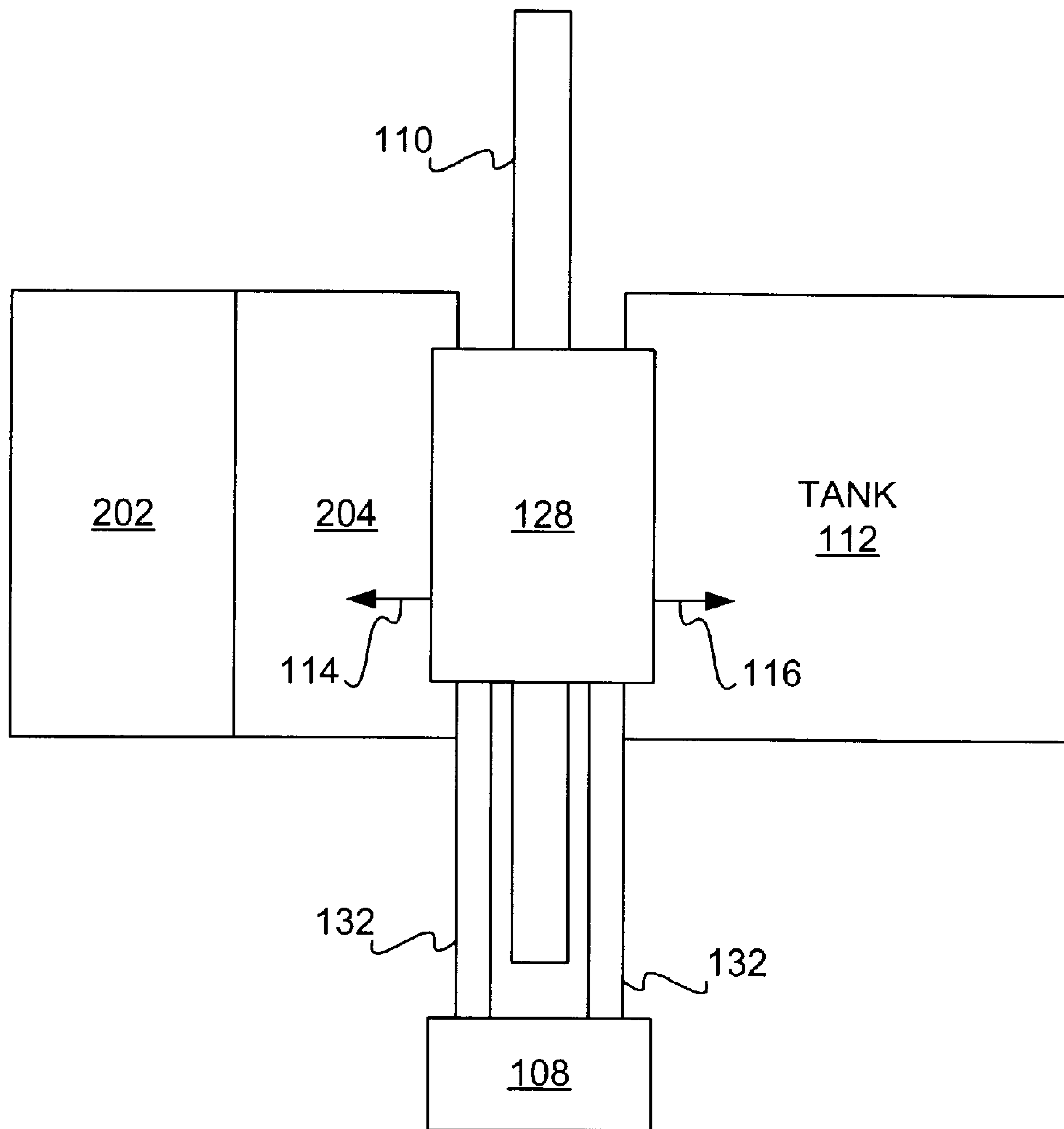


FIG 2B



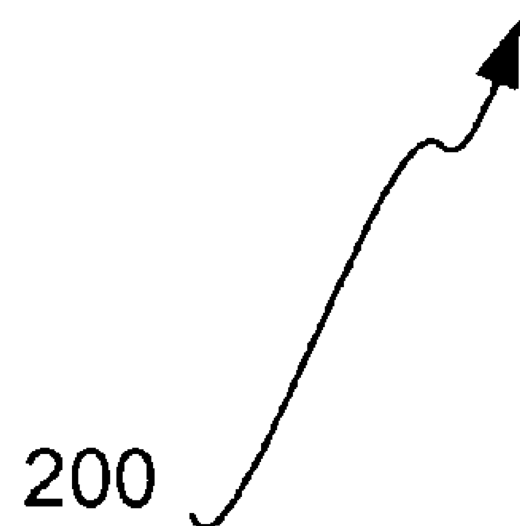
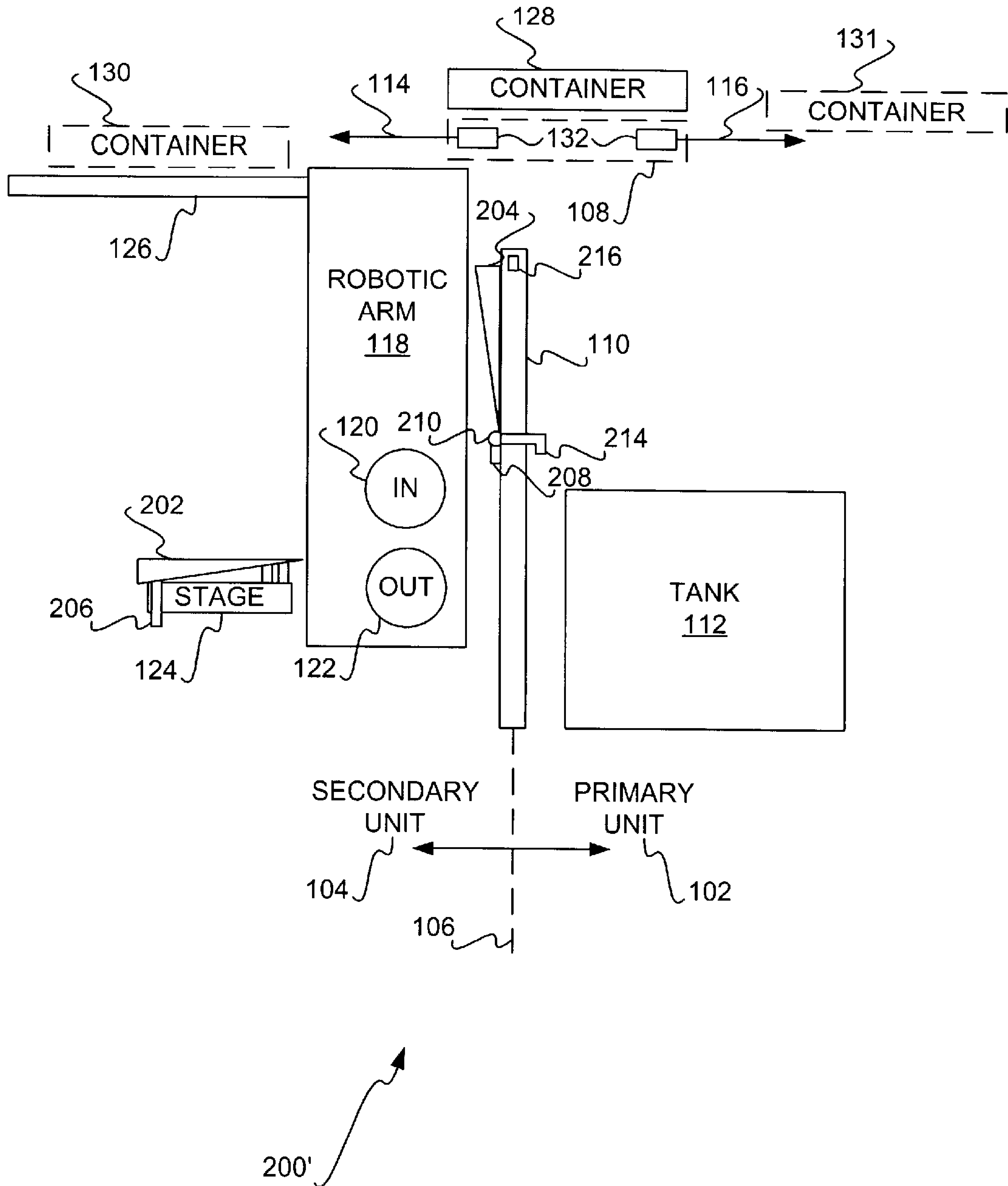


FIG 3A



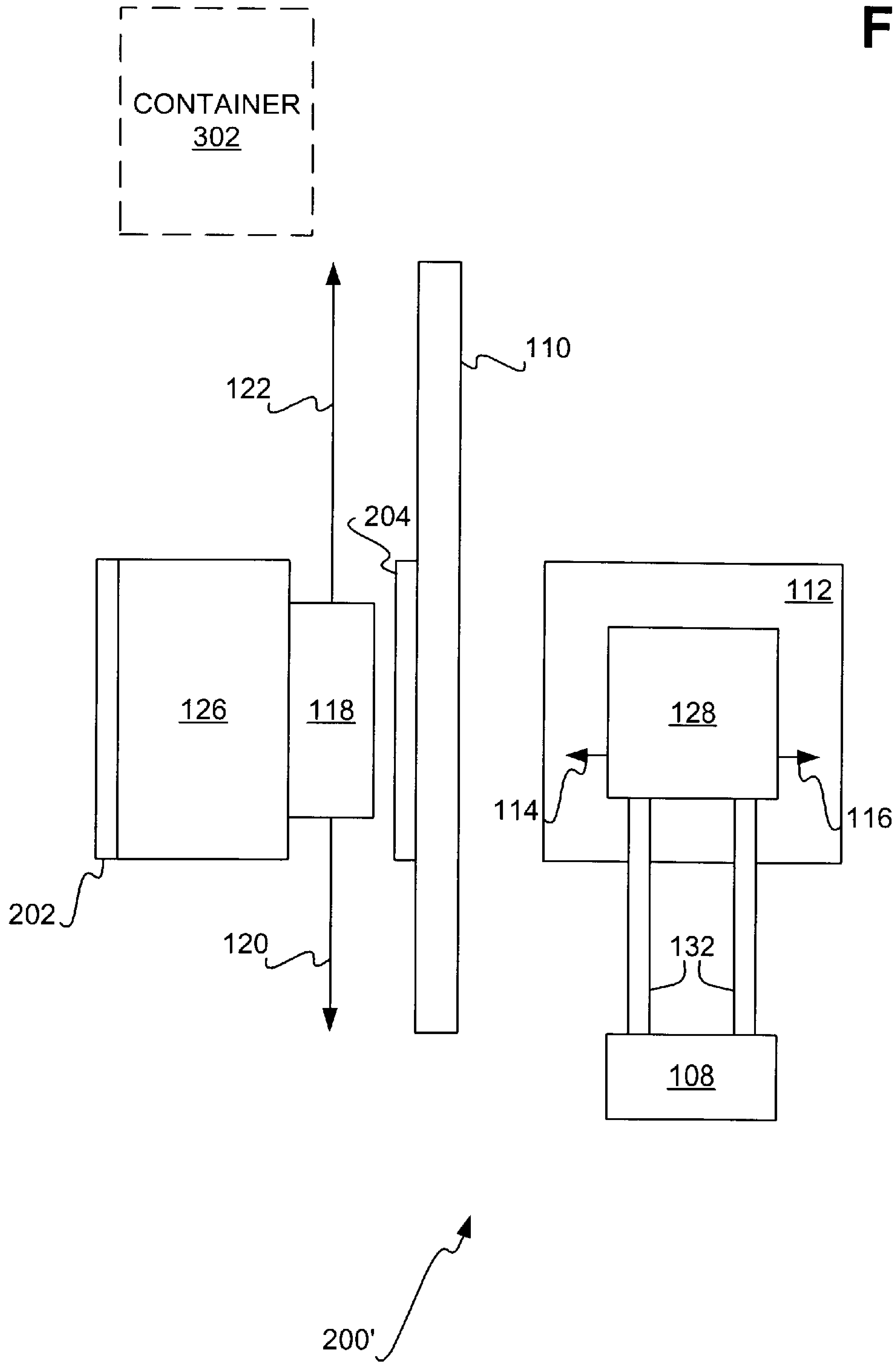


FIG 3B
CONTAINER
302
110
122
204
112
126
118
128
114
116
202
120
132
108
200'

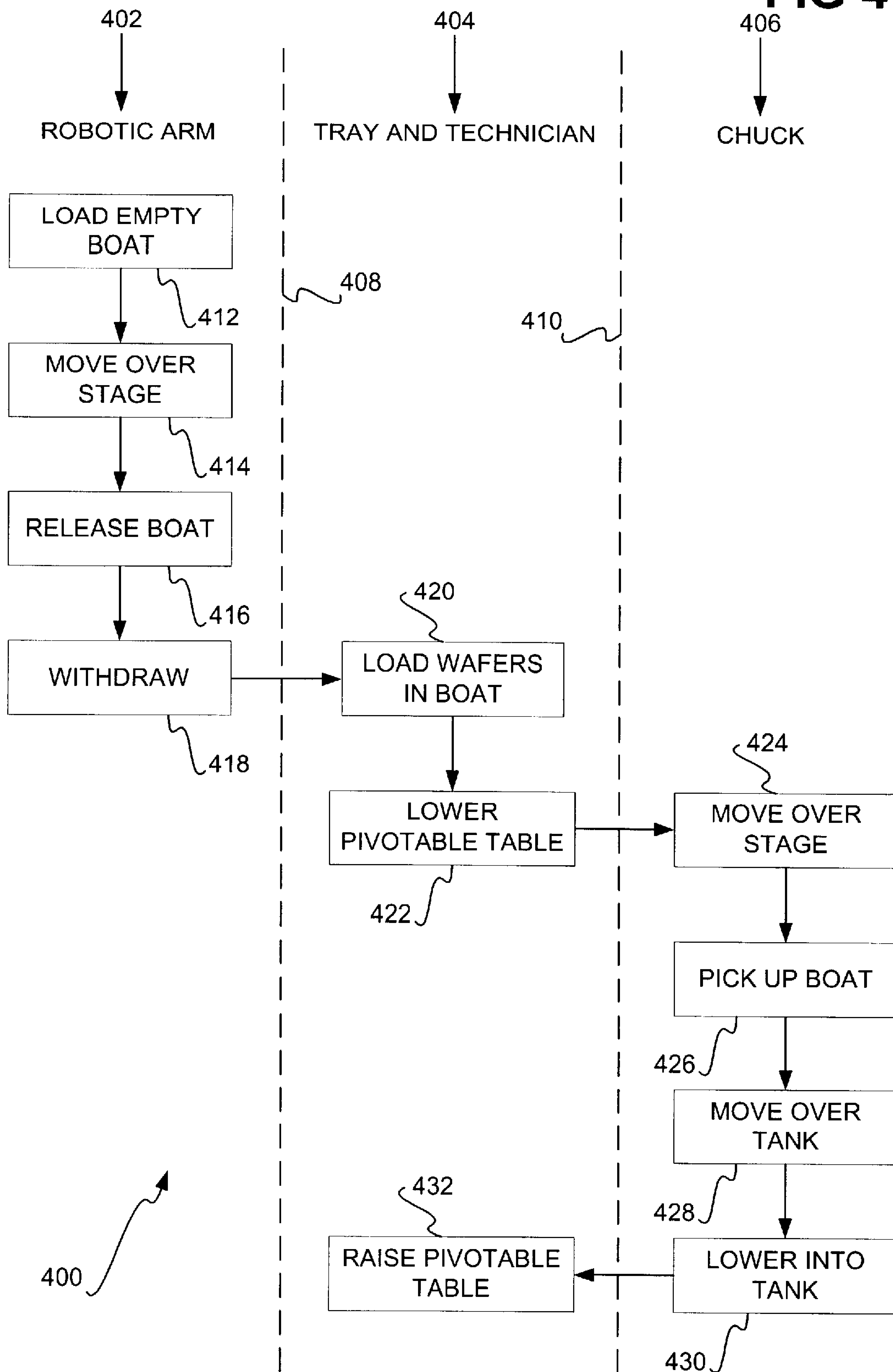


FIG 4
402
ROBOTIC ARM
404
TRAY AND TECHNICIAN
406
CHUCK
LOAD EMPTY BOAT
412
MOVE OVER STAGE
414
RELEASE BOAT
416
WITHDRAW
418
408
410
420
LOAD WAFERS IN BOAT
LOWER PIVOTABLE TABLE
422
424
MOVE OVER STAGE
PICK UP BOAT
426
MOVE OVER TANK
428
LOWER INTO TANK
430
432
RAISE PIVOTABLE TABLE
400

STATIONARY AND PIVOTABLE TRAYS FOR SEMICONDUCTOR WAFER TRANSFER

FIELD OF THE INVENTION

This invention relates generally to the transfer of semiconductor wafers among various semiconductor processing stations as well as other types of stations, and more particularly to collecting liquid dripping from moving equipment during such transfer.

BACKGROUND OF THE INVENTION

Semiconductor fabrication requires that a semiconductor wafer be processed in a variety of different manners. A wafer may be coated with photoresist, exposed to an ultraviolet light source to imprint a device pattern on the wafer, developed to remove the exposed photoresist, etched, and so on. Each different type of processing may require that the wafer be moved to a different processing station that is particular to a given type of processing. Therefore, the wafer must usually be transferred among different processing stations in order to fabricate devices on the wafer.

FIG. **1** shows an example system **100** in which wafer transfer is accomplished between a primary unit **102** and a secondary unit **104**, as separated conceptually by a dotted line **106** and physically by a wall **110**. A chuck **108** having arms **132** moves a container **128** horizontally between the primary unit **102** and the secondary unit **104**. The chuck **108** may be such a chuck as manufactured by and available from Robotek International, of Richardson, Tex. The chuck container **128** is more specifically a boat or a cassette. The container **128** moves horizontally as indicated by the arrows **114** and **116**. On the side of the primary unit **102**, the chuck **108** may at least assist in submersing the container **128**, and its contained semiconductor wafers, in an immersion tank **112**, for a wet bench process. The chuck **108** may thus move the container **128** to the container position **131**.

On the side of the secondary unit **104**, a robotic arm **118** is able to move the container **128** vertically into and out of the plane of FIG. **1**, as indicated by the in circle **120** and the out circle **122**, once the container **128** has been deposited by the chuck **108** in the container position **130**. The robotic arm **118** is able to accomplish its movement of the container **128** as a result of its arm **126**. The arm **126**, as well as the container position **130**, is over a stage **124** of the secondary unit **104**, as compared to the container position **131**, which is over and/or in the tank **112** on the side of the primary unit **102**. The robotic arm **118** may be such an arm as manufactured by and available from Kaijo Corp., of Tokyo, Japan. The robotic arm **118** is for moving from a container loading and unloading position, not shown in FIG. **1**, to the container position **130**, which is a wafer loading and unloading position. By comparison, the container position **131** is a wafer tank immersion position, such that the wafers can be immersed into the tank at this position. The position **131** may alternatively be located in the tank **112** as well.

A problem with the transfer of semiconductor wafers via the system **100** of FIG. **1** is that the caustic chemicals, or other liquid, in which the container **128** is immersed in the tank **112** may drip off chuck **108** when it is moving over the secondary unit **104**. The caustic chemicals are those necessary for performing a wet bench operation on the semiconductor wafers held within the container **128**. This can cause significant and rapid corrosion of the secondary unit **104**, as well as the robotic arm **118** and its arm **128**. The chuck **108** and the robotic arm **118** are more generally referred to as moving equipment, insofar as they move, or transfer, the container **128** and its contained semiconductor wafers.

A limited solution to this problem is to clean the chuck **108** before it is moved over the secondary unit **104**. For instance, there may be a chuck-cleaning bath in which overflowing deionized water and/or blowing nitrogen clean the residual chemicals from the chuck **108**. However, this is disadvantageous a at best. Chuck cleaning prolongs the transfer time from the primary unit **102** to the secondary unit **102**, such as by nearly sixty seconds. This lowers the number of wafers that can be processed on a per hour basis, increasing cost to the semiconductor manufacturer. Furthermore, extra facility space is required to house the chuck cleaning bath, which may be expensive at best or not always available at worst. Finally, the cleaning bath cannot completely clean the chuck **108**. Therefore, liquid dripping from the chuck **108** is only at best reduced, and thus at best only slows corrosion of the secondary unit **104**.

Therefore, there is a need within the art to overcome these disadvantages. Specifically, there is a need to prevent the chuck **108** from corroding the secondary unit **104** and the robotic arm **118** when it is moving over the secondary unit **104**. There is a need for complete prevention of such corrosion, and not just a decrease in the rate of corrosion. There is a need to prevent corrosion without slowing down the number of wafers that can be processed on an hourly basis, as well as without requiring extra space in the facility. For these and other reasons, there is a need for the present invention.

SUMMARY OF THE INVENTION

The invention relates to stationary and pivotable trays for semiconductor wafer transfer. A first moving equipment, such as a chuck, is movable to move a container for holding one or more semiconductor wafers from a wafer loading and unloading position to a wafer tank immersion position. A second moving equipment, such as a robotic arm, is movable to move the container from the wafer loading and unloading position to a container loading and unloading position. A stationary tray is located under the wafer loading and unloading position to collect liquid dripping from the first moving equipment. A pivotable tray is located to one side of the stationary tray, to collect the liquid dripping from the first moving equipment when this equipment is moving to the wafer loading and unloading position, such that the pivotable tray is lowered. The pivotable tray is raised when the second moving equipment is moving to the wafer loading and unloading position.

The invention provides for advantages over the prior art. The stationary and pivotable trays prevent the liquid dripping from the first moving equipment from corroding the second moving equipment, or other equipment, such as a secondary unit. The trays collect the dripping liquid, such that the first moving equipment does not have to be cleaned in a time-consuming bath, and such that the number of wafers that can be processed on an hourly basis is not decreased. Furthermore, the trays do not use potentially expensive facility space. Other advantages, embodiments, and aspects of the invention will become apparent by reading the detailed description that follows, and by referencing the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a diagram of a front view of a semiconductor wafer transfer system according to the prior art.

FIGS. **2A** and **2B** are diagrams of a front view and a top view, respectively, of a semiconductor wafer transfer system

according to an embodiment of the invention, in which a pivotable tray thereof is in a lowered position.

FIGS. **3**A and **3**B are diagrams of a front view and a top view, respectively, of the semiconductor wafer transfer system of FIGS. **2**A and **2**B, but in which the pivotable tray thereof is in a raised position.

FIG. **4** is a method according to an embodiment of the invention showing an example process in accordance with which the semiconductor wafer transfer system of FIGS. **2**A, **2**B, **3**A, and **3**B can be used.

DETAILED DESCRIPTION OF THE INVENTION

In the following detailed description of exemplary embodiments of the invention, reference is made to the accompanying drawings that form a part hereof, and in which is shown by way of illustration specific exemplary embodiments in which the invention may be practiced. These embodiments are described in sufficient detail to enable those skilled in the art to practice the invention. Other embodiments may be utilized, and logical, mechanical, and other changes may be made without departing from the spirit or scope of the present invention. The following detailed description is, therefore, not to be taken in a limiting sense, and the scope of the present invention is defined only by the appended claims.

FIGS. **2**A and **2**B show a front view and a top view, respectively, of a semiconductor wafer transfer system **200** according to an embodiment of the invention. Wafer transfer is accomplished between a primary unit **102** and a secondary unit **104**, as separated conceptually by a dotted line **106** and physically by a wall **110**. A chuck **108** having arms **132** moves a container **128** horizontally between the primary unit **102** and the secondary unit **104**. The chuck container **128** is more specifically a boat or a cassette. The container **128** moves horizontally as indicated by the arrows **114** and **116**. On the side of the primary unit **102**, the chuck **108** may at least assist in submersing the container **128**, and its contained semiconductor wafers, in an immersion tank **112**, for a wet bench process. The chuck **108** is more generally a piece of moving equipment. The container **128** can move to the position **131**, which is referred to as a wafer tank immersion position, such that the wafers can be immersed into the tank at this position. The position **131** may alternatively be located in the tank **112** as well.

While the chuck **108** is moving over the side of the secondary unit **104**, a pivotable tray **204** is in the lowered position, as shown in FIGS. **2**A and **2**B. The pivotable tray **204** pivots about a pivot mount, or point, **210**, and is caused to pivot as shown by the arrow **212** by a motor **208**. When the chuck **108** is moving over the pivotable tray **204**, the tray **204** collects any liquid dripping from the chuck **108**. A stationary tray **202**, to which side the pivotable tray **204** is located, protects the stage **124** of the secondary unit **104** from the liquid dripping from the chuck **108**, such that the stationary tray **202** collects this dripping liquid when the chuck **108** is so positioned thereover. A drain **206** on the stationary tray **202** drains the liquid collected by the stationary tray **202**. Similarly, a drain **214** connected to the tray **204** drains the liquid collected by the pivotable tray **204**, when the tray **204** is raised from its lowered position, or configuration, to its raised position, or configuration. A sensor **216** can be used to detect when the chuck **108** is moving to over the secondary unit **104**, such that the tray **204** should be lowered.

FIGS. **3**A and **3**B show a front view and a top view, respectively, of the wafer transfer system **200** when the pivotable tray **204** has been moved to its raised position, such that the system **200** is indicated as the system **200**' in

FIGS. **3**A and **3**B. Wafer transfer is accomplished in FIGS. **3**A and **3**B on the side of the secondary unit **104**, from over the stage **124** to over the container position **302** of FIG. **3**B, which is referred to as a boat loading and unloading position. Conversely, the container position **130** of FIG. **3**A is referred to as a wafer loading and unloading position. The robotic arm **118** is able to move the container **128** vertically into and out of the plane of FIG. **3**A, as indicated by the in circle **120** and the out circle **122**. The robotic arm **118** is able to accomplish its movement of the container **128** as a result of its arm **126**. The robotic arm **118**, with its arm **126**, is more generally a piece of moving equipment.

When the robotic arm **118** is moving to or from the container position **130**, the pivotable tray **204** is in the raised position, as shown in FIG. **3**A. This is because the pivotable tray **204** when lowered is in the path of the robotic arm **118**, such that it is raised to not block the path. The tray **204** furthermore can be raised because the chuck **108** has already moved away from over the secondary unit **104**, such that liquid dripping from the chuck **108** and onto the secondary unit **104** is no longer currently a concern. While the tray **204** is being raised, the liquid previously collected therein is drained via the drain **214**, whereas the liquid that is collected in the tray **202** over the stage **124** of the secondary unit **104** is drained during liquid collection via the drain **206**. The sensor **216** can be used to determine when the chuck **108** is no longer over the secondary unit **104**, such that the pivotable tray **204** can be raised.

As shown in various of the FIGS. **2**A, **2**B, **3**A, and **3**B, there are three denoted positions in this embodiment of the invention for the container **128**. In the position **302** of FIG. **3**B, the container **128** can be loaded on and unloaded from the robotic **4** arm **118**, specifically the arm **126** of the robotic arm **118**. In the position **130** of FIG. **3**A, the container **128** can have semiconductor wafers loaded thereon and loaded therefrom. Finally, in the position **131** of FIG. **2**A, the container **128**, and its contained semiconductor wafers, can be submersed into the tank **112**, to perform a wet bench or other type of semiconductor processing operating. In addition, those of ordinary skill within the art can appreciate that other aspects, components, and parts of the semiconductor wafer transfer system described with reference to

FIGS. **2**A, **2**B, **3**A, and **3**B may be present, and are not shown herein for purposes of illustrative clarity, and because they are not necessary to construction of aspects of the invention.

FIG. **4** shows an example method **400** that can be performed in accordance with the semiconductor wafer system that has been described. Various parts of the method **400** are performed by or at the robotic arm, the tray and the technician, and the chuck, as indicated by the columns **402**, **404**, and **406**, as separated by the dotted lines **408** and **410**. First, where the robotic arm is at the container loading and unloading position, which is more generally an inside position, an empty container, such as a boat or a cassette, may be loaded onto the arm (**412**). The robotic arm moves the container from this position to the wafer loading and unloading position over the stationary tray of the secondary equipment (**414**), where the container is released by the robotic arm (**416**). During movement, the pivotable tray is located in the raised position.

The technician then loads one or more semiconductor wafers into the container (**420**), and the pivotable tray is lowered (**422**) in preparation for the chuck moving over the secondary equipment to pick up the container, which now holds semiconductor wafers. The chuck thus moves over the stage to the wafer loading and unloading position (**424**), and picks up the container. The chuck then moves back to over the tank (**428**) to a wafer tank immersion position, also referred to more generally as an outside position. The

container can then be lowered into the tank to submerse the wafers in the container in the liquid of the tank (**430**). Furthermore, once the chuck has moved past the secondary equipment, the pivotable tray can be raised (**432**).

It is noted that, although specific embodiments have been illustrated and described herein, it will be appreciated by those of ordinary skill in the art that any arrangement is calculated to achieve the same purpose may be substituted for the specific embodiments shown. For example, whereas the stationary and pivotable trays of the invention have been described in relation to a semiconductor wafer transfer scenario, the invention itself is not so particularly limited. This application is intended to cover any adaptations or variations of the present invention. Other applications and scenarios, besides that of semiconductor wafer transfer, are also amenable to the invention's stationary and pivotable trays. Therefore, it is manifestly intended that this invention be limited only by the claims and equivalents thereof.

What is claimed is:

1. An apparatus for transferring semiconductor wafers comprising:

a first moving equipment movable to move a container for holding one or more semiconductor wafers from a wafer loading and unloading position to a wafer tank immersion position;

a second moving equipment movable to move the container from the wafer loading and unloading position to a container loading and unloading position;

a stationary tray located under the wafer loading and unloading position to collect liquid dripping from the first moving equipment; and

a pivotable tray located to one side of the stationary tray to collect the liquid dripping from the first moving equipment when the first moving equipment is moving to the wafer loading and unloading position, such that the pivotable tray is lowered,

the pivotable tray raised when the second moving equipment is moving to the wafer loading and unloading position.

2. The apparatus of claim **1**, further comprising:

a primary transfer unit, the wafer tank immersion position located at least one of in and over the primary transfer unit; and,

a secondary transfer unit, the wafer loading and unloading position located over the secondary transfer unit.

3. The apparatus of claim **2**, wherein the primary transfer unit comprises a tank into which the container is lowered by the first moving equipment.

4. The apparatus of claim **2**, wherein the secondary transfer unit comprises a stage over which the stationary tray is located.

5. The apparatus of claim **1**, further comprising:

a first drain for the stationary tray to drain the liquid collected by the stationary tray; and

a second drain for the pivotable tray to drain the liquid collected by the pivotable tray as the pivotable tray is raised.

6. The apparatus of claim **1**, further comprising:

a pivot point about which the pivotable tray pivots from a raised configuration to a lowered configuration, and from the lowered configuration to the raised configuration; and

a motor to pivot the pivotable tray from the raised configuration to the lowered configuration, and from the lowered configuration to the raised configuration.

7. The apparatus of claim **1**, further comprising a sensor to detect when the first moving equipment is moving to the wafer loading and unloading position and correspondingly cause the pivotable tray to be lowered.

8. The apparatus of claim **1**, wherein the first moving equipment comprises a movable chuck.

9. The apparatus of claim **1**, wherein the second moving equipment comprises a movable robotic arm.

10. The apparatus of claim **1**, wherein the container comprises one of a boat and a cassette.

11. An apparatus comprising:

a first moving equipment horizontally movable to move a container from a first position to a second position;

a second moving equipment vertically movable to move the container from the second position to a third position;

a stationary tray located under the second position; and

a pivotable tray located to one side of the stationary tray in a path of the second moving equipment when the second moving equipment has moved the container to the second position,

the pivotable tray lowered when the first moving equipment is moving the container from the first position to the second position, and raised when the second moving equipment is moving the container to the second position.

12. The apparatus of claim **11**, further comprising a primary unit, the first position of the container located at least one of in and over the primary unit.

13. The apparatus of claim **11**, further comprising a secondary unit, the second position of the container located over the secondary unit.

14. The apparatus of claim **11**, further comprising a tank into which the container is lowered by the first moving equipment.

15. The apparatus of claim **11**, wherein the first moving equipment comprises a movable chuck.

16. The apparatus of claim **11**, wherein the second moving equipment comprises a movable robotic arm.

17. The apparatus of claim **11**, wherein the container holds one or more semiconductor wafers.

18. The apparatus of claim **17**, wherein the container comprises one of a boat and a cassette.

19. A method for transferring semiconductor wafers comprising:

moving a container for holding one or more semiconductor wafers via a second moving equipment from an inside position to a wafer loading and unloading position over a stationary tray, such that a pivotable tray has been raised;

releasing the container from the second moving equipment, the second moving equipment subsequently withdrawing;

moving a first moving equipment to the wafer loading and unloading position over the stationary tray, such that the pivotable tray has been lowered;

picking up the container by the first moving equipment, where one or more semiconductor wafers have already been loaded into the container; and

moving the container via the first moving equipment from the wafer loading and unloading position to an outside position, the pivotable tray subsequently being raised.

20. The method of claim **19**, the outside position comprising a wafer tank immersion position, the first moving equipment allow for the container to be lowered into a tank at the wafer tank immersion position, and the inside position comprising a container loading and unloading position at which the container is loaded onto the second moving equipment.

* * * * *